

GENERATION IV PROJECT EVALUATION METHODOLOGY

Evaluation Methodology Group

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RESPONSIBILITIES

The main responsibilities of the EMG are to:

- ***Support the Roadmap Integration Team (RIT) in defining the overall evaluation process (schedules, evaluation scope, etc.)***
- ***Develop a methodology for evaluating the performance of candidate concepts against the goals and for prioritizing R&D requirements***
- ***Define the evaluation criteria and metrics employed in the evaluation methodology***
- ***Support the RIT and Technical Working Groups (TWGs) in applying the evaluation methodology during the screening evaluations***
- ***Review the RIT/TWG screening evaluations for proper implementation of the evaluation methodology***

SCREENING FOR POTENTIAL

- **Purpose**
 - ***Screening For Potential is to identify and include those nuclear energy system concepts that meet the purpose and principles of the Generation IV initiative and have the potential for significant progress toward the established goals.***
- **Mindset**
 - ***The error of concern at this stage is to discard a “winning” concept.***
(TWG burden: Justify dropping a concept.)
 - ***The error of concern at later stages is to retain a “losing” concept.***
(TWG burden: Justify retaining a concept.)



GEN IV PRINCIPLES

- ***Gen IV Systems Must be Responsive to the Needs of a Broad Range of Nations and Users.***
- ***The Gen IV Roadmap Must Consider Complete Systems, Not Simply Reactor Technologies.***
- ***Technology Goals for Gen IV Must Be Aggressive***
- ***All Promising Technologies Must Be Considered***

Sustainability–1. Generation IV nuclear energy systems and fuel cycles will provide sustainable energy generation that meets clean air objectives and promotes long-term availability of systems and effective fuel utilization for worldwide energy production.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
SU1-1	Fuel utilization	Estimate relative to LWR (++/+/=/-/--)	$M1 = [(F/R)_V / (F/R)_0]$	
SU1-2	Fuel cycle impact on environment	Estimate relative to LWR (++/+/=/-/--)	Same, possibly more refined	$M2 = [(A/R)_V / (A/R)_0]$
SU1-3	Utilization of other resources	Estimate relative to LWR (++/+/=/-/--)	Same, possibly more refined	$M3 = [(m_k/R_k)_V / (m_k/R_k)_0]$

Sustainability–2. Generation IV nuclear energy systems will minimize and manage their nuclear waste and notably reduce the long term stewardship burden in the future, thereby improving protection for the public health and the environment.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
SU2-1	Waste Minimization	HLW/SNF quantity/GWyr relative to LWR once- through cycle (++/+/=/-/--)	<i>Same, but quantify: Ton/GWyr MW-decay/GWyr Ci long-lived/GWyr</i>	<i>Same, but add - waste form performance - dose (repository specific)</i>
SU2-2	Environmental impact	Estimate relative to LWR (++/+/=/-/--)	<i>Same, possibly more refined</i>	<i>Semi-quantitative environmental evaluation (EIS issues that discriminate)</i>
SU3-3	Stewardship burden	Estimate relative to LWR (++/+/=/-/--)	<i>Same, possibly more refined</i>	<i>Evaluate length and level of societal responsibility</i>

Sustainability–3. Generation IV nuclear energy systems and fuel cycles will increase the assurance that they are a very unattractive and least desirable route for diversion or theft of weapons-usable materials.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
SU3-1	Material life-cycle vulnerability	Isotopic, chemical, radiological, mass and bulk, detectability (++/+/=/-/--)	<i>Same, possibly more refined</i>	<i>Sub-goal/cycle matrix assessment of vulnerabilities (intrinsic and extrinsic)</i>
SU3-2	Facilitate application of extrinsic barriers	Features that facilitate international safeguards monitoring (++/+/=/-/--)	<i>Same, possibly more refined</i>	
SU3-3	Unique characteristics	(++/+/=/-/--)	<i>Same, possibly more refined</i>	

Safety and Reliability – 1. Generation IV nuclear energy systems operations will excel in safety and reliability.

Summary table of criteria and metrics

CRITERION		Screening For Potential	<i>Final Screening & R&D Prioritization</i>	<i>Viability and Performance Evaluations</i>
SR1-1	Reliability	Screen for unique characteristics such as controls, maintenance, refueling,...) (++/+/=/-/--)		<i>Forced outage rate probability distribution</i>
SR1-2	Public and worker safety – routine exposures	Screen for the possibility of unique routine exposure to radiation, chemical, and toxic hazards (++/+/=/-/--)		
SR1-3	Worker safety – accidents	Screen for unique radiation, chemical, toxic, handling hazards (++/+/=/-/--)		

Safety and Reliability–2. Generation IV nuclear energy systems will have a very low likelihood and degree of reactor core damage.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
SR2-1	Facility state is simple to characterize and predict (passive/ redundant)	(++/+/=/-/--)	Same, possibly more refined	Probability distribution for core damage frequency (or release from normal configuration for non-reactor facilities)
SR2-2	System models have small and well-characterized uncertainty (physical models / well-scaled experiments)	(++/+/=/-/--)	Same, possibly more refined	
SR2-3	Unique characteristics	(++/+/=/-/--)	Same, possibly more refined	

Safety and Reliability-3. Generation IV nuclear energy systems will eliminate the need for offsite emergency response.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
SR3-1	Highly robust mitigation features	(++/+/=/-/-)	Same, possibly more refined	Release or dose probability distribution
SR3-2	Damage, transport, site boundary dose understood	(++/+/=/-/-)	Same, possibly more refined	
SR3-3	No additional individual risk	n/a	Same, possibly more refined	Quantitative
SR3-4	Societal risk comparable to competing technology	n/a	Same, possibly more refined	Quantitative

Economics 1: Generation IV nuclear energy systems will have a life-cycle cost advantage over other energy sources.

Economics 2: Generation IV nuclear energy systems will have a level of financial risk comparable to other energy projects.

Summary table of criteria and metrics

CRITERION		Screening for Potential	Final Screening and R&D Prioritization	Viability and Performance Evaluations
EC-1	Low capital costs	Simplicity, scalability, volume (++/+/=/-/--)	<i>Same, possibly more refined</i>	<i>Capital cost per KWh distribution</i>
EC-2	Low financial costs	Financial risk assessment (++/+/=/-/--)	<i>Same, possibly more refined</i>	<i>Licensing uncertainties/ financing costs</i>
EC-3	Low production costs	Fuel types, special waste or maintenance (++/+/=/-/--)	<i>Fuel requirements, refueling process</i>	<i>Time and cost to resolve uncertainties</i>
EC-4	Low development costs	Identify major technical uncertainties (++/+/=/-/--)	<i>Time and cost to resolve uncertainties during R&D</i>	<i>Time and cost to resolve uncertainties during R&D</i>
EC-5	High profitability	Other commercial products (++/+/=/-/--)	<i>Value of other commercial products</i>	<i>Net Revenue Probability Distribution</i>



SCREENING FOR POTENTIAL SCORESHEET

Concept name: _____

Summary Evaluation: ____ Retain ____ Reject

Scoring by Goal	Much worse than reference --	Worse than reference -	Similar to reference =	Better than reference +	Much bet than refere ++
Goal Sustainability 1					
SU1-1 Fuel Utilization					
SU1-2 Fuel cycle impact on environment					
SU1-3 Utilization of other resources					
Goal Sustainability 2					
SU2-1 Waste minimization					
SU2-2 Environmental impact					
SU2-3 Stewardship burden					
Goal Sustainability 3					
SU3-1 Material life-cycle vulnerability					
SU3-2 Application of extrinsic barriers					
SU3-3 Unique characteristics					
Goal Safety and Reliability 1					
SR1-1 Public/worker - routine exposures					
SR1-2 Worker safety - accidents					
SR1-3 Reliability					
Goal Safety and Reliability 2					
SR2-1 Facility state transparency					
SR2-2 System model uncertainty					
SR2-3 Unique characteristics					
Goal Safety and Reliability 3					
SR3-1 Highly robust mitigation features					
SR3-2 Damage/transport/dose understood					
SR3-3 No additional individual risk					
SR3-4 Comparable societal risk					
Goal Economics 1 and Goal Economics 2					
EC-1 Low capital costs					
EC-2 Low financial costs					
EC-3 Low production costs					
EC-4 Low development costs					
EC-5 High profitability					